NUI Galway
OÉ Gaillimh

Semester I Examinations 2009/ 2010

Exam Code(s)	4IF, 4BP, 3BA, 1SD
Exam(s)	4th Year B.Sc. (Information Technology) 4th Year B.E. (Electronic & Computer Engineering) 3rd Year B.A. (Information Technology) Higher Diploma in Applied Science (Software Design & Development)
Module Code(s)	CT404, CT336
Module(s)	GRAPHICS AND IMAGE PROCESSING
Paper No.	I
Repeat Paper	
External Examiner(s)	Prof. M. O'Boyle
Internal Examiner(s)	Prof. G. Lyons * Dr. S. Redfern
Instructions:	Answer any three questions. All questions carry equal marks.
Duration	2 hours
No. of Pages	5
Department(s)	Information Technology
Course Co-ordinator(s)	

Requirements:

MCQ	Release to Library: Yes ☐ No ☐
Handout	
Statistical/ Log Tables	
Cambridge Tables	
Graph Paper	Required
Log Graph Paper	
Other Materials	

Q.1.

(i) Describe the use of extrusion in VRML, referring to each of the seven fields used by the Extrusion node. Note that extrusion and other useful nodes from the VRML language are summarised on the final page of this exam paper. **(*5 marks*)**

(ii) Write VRML code to make a model of a coffee table (example illustrated on the right). (***15 Marks).***

- The model should be as geometrically accurate as possible
- Use graph paper to sketch your model before coding the VRML
- The model should use a woodgrain texture as the material for its shapes. You can assume that a file called "wood.jpg" is available for this purpose.

Q.2.

(i) *"GLUT is an additional library that is often used in conjunction with OpenGL in order to provide platform-independent development of graphics applications for windowed operating systems."*
Discuss this statement. ***(8 marks).***

(ii) Why are nested co-ordinate systems useful for 3D graphics/animation programming? In your answer, explain and provide code samples illustrating the use of nested co-ordinate systems in both OpenGL and VRML. ***(8 marks).***

(iii) What are back buffers used for in computer animation? In your answer, explain how to use back buffers in OpenGL. ***(4 marks).***

Q.3.

(i) Many of the techniques used in real-time 3D graphics programming attempt to maximise the realism of the rendered scene while processing a minimal number of polygons. With specific reference to this 'polygon budget', and using diagrams where appropriate, discuss each of the following five techniques ***(5 x 3 = 15 marks).***

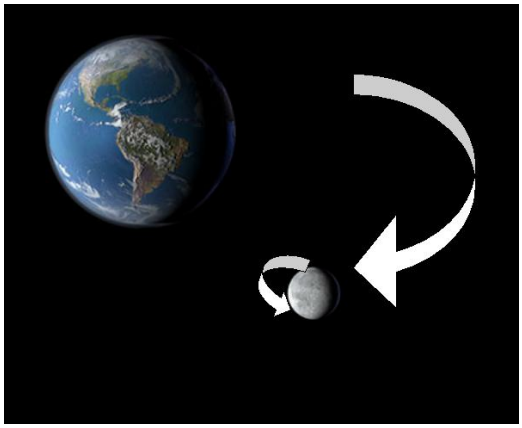
a) Frustum Culling
b) Bump Mapping
c) Binary Space Partitioning
d) Billboards
e) Levels-of-Detail (LODs)

(ii) Discuss the Lambert, Gourard and Phong Shading algorithms, illustrating your answer with diagrams ***(5 marks)***.

Q.4.

(i)

Write VRML code to produce an animation of a moon moving around a static earth. You should assume that two jpeg files "earth.jpg" and "moon.jpg" have been provided for you to texture map onto two spheres. The moon should rotate on its own axis as well as around the earth. Note that the most useful VRML nodes are summarised on the final page of this exam paper. ***(8 marks).***



(ii) Explain the *keyframe* approach to animation in computer graphics, and explain its use in VRML, referring to the *TimeSensor, Transform, OrientationInterpolator* and *PositionInterpolator* nodes in your answer. ***(6 marks)***

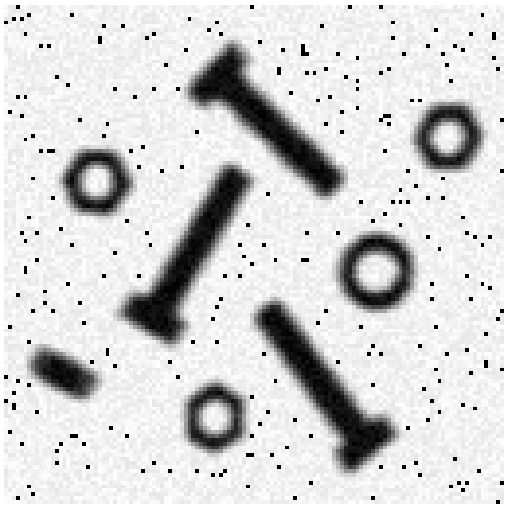
(iii) A more powerful approach to producing animations in VRML is to use *JavaScript* nodes to dynamically calculate positions or orientations. Write VRML code for a *JavaScript* node which produces a smooth elliptical motion, and which is suitable for use with a *TimeSensor* and a *Transform* node ***(6 marks).***

Q.5.

(i) Many automatic image analysis algorithms begin by smoothing an image, and then applying an edge extraction filter in order to ascertain the evidence for the edges of objects in the image. Discuss the use of smoothing and edge detection for these purposes. ***(6 marks)***

(ii) Describe the *mathematical morphology* approach to image processing. Outline some typical circumstances in which this approach is useful ***(6 marks).***

(iii) Pictured below is a binary image which contains nuts and bolts as well as noise pixels. Outline and discuss an image processing algorithm for automatic isolation and counting of nuts and bolts in images such as this ***(8 marks).***



Some useful VRML node information:

```
Shape
{
       geometry
       appearance
}

Transform
{
  children    [ ]
  translation 0.0  0.0  0.0
  rotation    0.0  0.0  1.0  0.0
  scale       1.0  1.0  1.0
  center      0.0  0.0  0.0
}

TimeSensor
{
  enabled            TRUE
  startTime          0.0
  stopTime           0.0
  cycleInterval      1.0
  loop               FALSE
  isActive           # eventOut
  time               # eventOut
  cycleTime          # eventOut
  fraction_changed   # eventOut
}

PositionInterpolator
{
  key   [  ]
  keyValue [  ]
  set_fraction   # eventIn
  value_changed  # eventOut
}

OrientationInterpolator
{
  key   [  ]
  keyValue [  ]
  set_fraction       # eventIn
  value_changed      # eventOut
}

Extrusion
{
  crossSection [ ]
  spine        [ ]
  scale        [ ]
  orientation  [ ]
  beginCap
  endCap
  creaseAngle
}
```

```
Box
{
       size 2.0 2.0 2.0
}


Sphere
{
       radius              1.0
}

Cylinder
{
       radius              1.0
       height              2.0
       side                TRUE
       top                 TRUE
       bottom              TRUE
}

Appearance
{
       material
}

Material
{
       diffuseColor
       specularColor
       ambientIntensity
       emissiveColor
       transparency
       shininess
       texture
}

ImageTexture
{
       url
}
```

Co-ordinates for a circle-shaped cross section, suitable for extrusion:

```
1.00 0.00,    0.92 -0.38,
0.71 -0.71,   0.38 -0.92,
0.00 -1.00,   -0.38 -0.92,
-0.71 -0.71,  -0.92 -0.38,
-1.00 0.00,   -0.92 0.38,
-0.71 0.71,   -0.38 0.92,
0.00 1.00,    0.38 0.92,
0.71 0.71,    0.92 0.38,
1.00 0.0
```